

COMMENTS ON NDE

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I have prepared some comments for some specific topics we touched upon yesterday. We have a lot to learn toward perfecting nondestructive testing in any area. The Federal Government of Germany has funded us for approximately five years. The Institute for Nondestructive Testing started experimental work about three years ago. We are covering different topics, mainly keeping in mind the application to heavy section materials--the nuclear industry, the steel industry--but to some extent, recently work has also been started on smaller sections and ceramics. We consider non-destructive testing not as just a method for depicting and describing defects, but more as a general method to judge the material, its structure, and the state of stress. Furthermore, the society to whom we belong (the Fraunhofer Society) is heavily devoted to technology aspects. That means that we must regard nondestructive testing as a technology and become involved in the more practical difficulties that arise. In practice, we follow the development of the technology until industry takes over. That is roughly the scope of work at our institution.

Let me give you a brief overview on our work. We have already heard so much about ultrasonics that I will not talk about it for the moment. One field we are heavily involved in is the eddy current technique. Starting with the basic ideas given by Libby at Battelle, Northwest, we have developed a device for multifrequency eddy current testing, and we have also developed the software to calculate what is going on in the material during eddy current testing which includes the design and the optimization of equipment parameters to design the coils. This work has been published and is very advanced. We are now cooperating with industry to get this technique applied in the nuclear industry as well as in the steel industry.

Another method uses a dc current to detect and to quantify defects. It is a very simple method using two electrodes on a work piece, which might have a very complicated shape. Measuring the change of the potential drop at the surface one is able to say something about the size and presence of a crack. To apply this method, which is particularly sensitive to deep cracks, we have developed a finite element program covering any geometrical shape. This method has been applied successfully to different cases.

Coming back to the eddy current technique, I would like to mention that it is not only able to detect defects but also useful for judging the structure of materials. Those of you who are familiar with the impedance curves know that the permeability and the conductivity are sensitive to the materials' structure. Using a multifrequency eddy current technique one is able to determine permeability and conductivity on any piece of metal of any shape. This is particularly important for weld inspection since permeability depends strongly on the demagnetization

factor, that means on the size of the delta ferrite particles.

Furthermore, we are developing a theory of the magnetic leakage. You may know that this method normally is used with powder indications, but you can also use a magnetic tape, place it on the surface and afterwards scan the tape for the presence of cracks. One may also calculate the geometry of the crack, thus having a quantitative basis for application of the magnetic leakage method which is very sensitive to narrow and small cracks. Very recently we started with magnetic noise measurements, where we have two things in mind; the stress--I think some people in the auditorium have already worked in that field--and small inclusions or small precipitates below one micron in diameter. This is very important, for instance, during annealing at temperatures of about 650°C, some carbides and nitrides determine the strengths and the toughness of the materials. Ultrasonic methods are not capable of giving information on these very small precipitates. Magnetic noise, however, is very sensitive because the size of these precipitates is comparable to the thickness of magnetic domain walls.

Let us talk now about ultrasonics. Again, we are trying to determine the materials' structure, defect sizes, and the stress. With regard to materials' structure, we have done a lot of scattering work but not scattering in the sense it was discussed and presented yesterday. We have determined grain scattering, or scattering of single and multiple inclusions. The grain scattering is caused by the anisotropy of the grains yielding a method for an absolute and quantitative determination of an average grain size. Important with regard to application to fracture mechanics is the fact that not only the size of the crack and the materials' strength have to be known, but also the specifics of the matrix immediately around the crack. This latter aspect is particularly important for weldments which may have a completely different structure than the parent material.

A second topic in the ultrasonic field is the electrodynamic excitation of ultrasound. The basic advantage of this method is contact-free generation of sound. Not all of the physically possible wave modes have been utilized yet. We have developed probes for tube testing and multi-mode plate testing. Different probes generate different wave types and a dynamic range of 50 decibels has been obtained.

Other work deals with ultrasonic holography. One may simply use equipment which has been developed in the U. S. Not only at our place, but also at other institutions in Germany, work is going on to develop procedures for numerical reconstruction of holograms. In conclusion, let me say that it is nice to see the basic scattering work proceeding which is necessary to interpret defect sizes and shapes and that a very important part

of this research is going on here. I think it is a good area for complimentary cooperation. I am sorry that I could not go into more details on the ongoing efforts in Germany in these few minutes.

Thank you very much.